Your guide to practical products, technologies and applications

Automation NOTEBOOK®

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* The programming software is free when downloaded from the AutomationDirect Web site, or the CD-ROM package can be purchased for $25 (part # EA-MG-PGMSW).

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Your guide to practical products, technologies and applications

Contributors

Publisher Tina Gable

Managing Editor Joan Welty

Coordinating Editor TJ Johns

Design Manager Justin Stegall

Contributing Writers
Christine Lesher
Sammy Natsui
Barry Hupp
Jason Horine
Tim Roberts
William Rossey

CONTACTS
Automationdirect.com Inc.
3505 Hutchinson Road
Cumming, GA 30040

Phone 1-800-633-0405
or 1-770-889-2858
Fax 1-770-889-7876

Monday - Friday
9 a.m. to 6:00 p.m. EST

www.automationdirect.com

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For those who prefer to speak with us in person, please call 1-800-633-0405 x1845. Thanks for your interest, and we look forward to hearing from you.

Editor's Note

Back in 1994, a tiny company, known as PLCDirect, was formed on the idea of making PLC products available through a direct sales catalog. While the large automation control suppliers thought it was a bad idea, one company liked the concept. That's when Koyo Electronics, designers and manufacturers of PLCs for some of the world's largest automation companies turned their attention toward the small town of Cumming, Georgia and made PLCDirect the first to sell micro PLCs through mass marketing, promoting the Koyo brand to an already large installed base of its private-branded products.

Since that time, that small PLC company grew and became AutomationDirect. But PLCs such as the well-known *Direct*LOGIC series, and newer entries such as CLICK, are still the heart and core of the business. For that we say, "Thank you, Koyo Electronics."

This issue of NOTEBOOK is chock full of informative technical articles, new product announcements and more. You'll learn in our User Solution story how Viking Range uses products from AutomationDirect to turn out reliable cooking equipment. You'll also see in our Student Spotlight how a group of students in Ohio are restoring gas turbines for alternative uses. Plus, our feature story details how a Michigan company breathed new life into old equipment.

Don't forget to visit the ever-popular Breakroom. Test your wits to see if you can solve the mind teasers. But, most of all, sit back, relax, and turn the page…

TJ Johns
Coordinating Editor
editor@automationnotebook.com

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New Product Focus

what's new

AutomationDirect launches new Do-more PLC and Counter Module

AutomationDirect has released the latest addition to its PLC offerings, the Do-more H2 Series PLC. This new PLC line offers features and performance of high-end PLCs for an economical price.

Using the proven *Direct*LOGIC DL205 hardware as a platform, the Do-more H2 PLC supports all base units, discrete and analog I/O modules available for the DL205 PLC. However, it has a much more flexible and advanced design that makes integrating I/O and organizing a program much easier. The H2 CPUs offer four times more program memory, nine times more data memory, and operate at speeds up to 20 times faster than current DL205 CPUs. "Higher processor speeds not only decrease program execution time, but also allow the CPUs to support Ethernet connectivity and custom communication protocols as built-in functions", says Sammy Natsui, AutomationDirect's PLC product manager.

A Do-more CPU installed in a DL205 9-slot base supports up to 256 I/O points. The I/O Configuration window performs full auto-discovery of all I/O modules in the local base, simplifying system configuration.

For larger applications, one or more Remote I/O Master modules installed in the local base can each connect to up to 16 remote I/O subsystems, which can provide hundreds of additional I/O points.

H2 series CPUs reduce system cost and space by including embedded communications ports. The H2-DM1 CPU with one serial and one USB port sells for $299; the H2-DM1E also includes an embedded Ethernet port for just $399. "Device abstraction" makes it easy to connect external devices by allowing the user to assign logical names and then refer to those names throughout the program code for ease and clarity.

Programmed using Do-more Designer software that can be download free of charge, the Do-more PLC provides an advanced instruction set to reduce programming time, superior memory mapping to improve data management, and data structures to simplify initial programming and long-term software maintenance.

The Do-more PLC enables developers to write program code before selecting the specific target hardware. Nicknames can be assigned to inputs and outputs, then later tied to the physical configuration. Within data memory, the developer can allocate partition size by variable types for maximum flexibility.

Natsui points out further advantages of the new software, saying, "With a wide array of high-level program blocks in Do-more, developers can use two or three instructions to program functionality that used to require many lines of hard-to-understand ladder logic." This simplifies and speeds development, and also promotes standardization. For example, the Spreadsheet style MATH instruction allows mixing of data types, and accepts formulas and variables. The MATH instruction also allows nesting with parentheses to 8 levels, and supports Trig and Statistical functions.

Do-more Designer's built-in simulator creates a virtual PLC so logic can be tested without a PLC present. The tool simulates discrete and analog I/O, with access to timers, counters and control bits, as well as the PID function.

The accompanying next-generation high-speed counter module (H2-CTRIO2, priced at $299) has four independently configurable timer/counter channels (up to 250 kHz) and two pulse output generators (up to 250 kHz). All configuration and profile setup functions are built into the Do-more Designer software to integrate the module with the application logic.

Two available starter kits provide a prewired, 3-slot base with choice of Do-more CPU, an 8-point input simulator module, and an 8-point relay output module. Also included are a copy of the Do-more Designer software on CD, a hard copy of the user manual, a USB programming cable, and a coupon for free online training. Starter kits start at $536.

For more information, please visit: **www.automationdirect.com/do-more-plcs.**

SPEND LESS. Do-more!

with the new supercharged Do-more™ PLC

If you've been using *DirectLOGIC* 205 PLCs, but you've been wanting ...

- ***More program memory***
- ***More and flexible data type memory***
- ***Faster program execution***
- ***Easier-to-use instruction set***
- ***Integrated Ethernet on the CPU***
- ***Faster I/O for counting and motion applications***
- ***More and easier-to-use communications***

... THE WAIT IS OVER!

The **new Do-more H2 series** CPUs leverage the existing line of DL205 I/O modules and base units to create an incredibly powerful PLC - at an incredible bargain.

Two CPU options are available:

H2-DM1E

H2-DM1

H2-DM1E	**$399**	(1) USB port for programming, (1) full-duplex serial port, (1) Ethernet port
H2-DM1	**$299**	(1) USB port for programming, (1) full-duplex serial port

- Over 1M bytes total memory *(includes program, data and documentation)*
- Program/monitor/debug over any embedded communication port.
- Supports up to 256 I/O locally and thousands more with optional Ethernet remote I/O.
- Supports inexpensive serial port expansion for connection to bar code readers, printers, etc.

And each Do-more CPU comes with a coupon for a 30-day free trial of online video training.

Built-in simulator

Program Do-more with the **completely new - and FREE - Do-more Designer software.** (*Direct*SOFT and ladder programs developed with ***Direct***SOFT are not compatible with these CPUs.) Download the **FREE** software!

Get started fast!

Choose a Do-more starter kit to get going fast. You get:

- Prewired, 3-slot base** with your choice of Do-more CPU
- 8-point input simulator module
- 8-point relay output module
- Do-more Designer software CD-ROM
- USB programming cable
- User manual
- **Coupon for 30 days FREE online video training**

** AutomationDirect reserves the right to substitute a larger base at its discretion

Starter Kit

H2-DM1E-START	**$626**	with H2-DM1E CPU
H2-DM1-START	**$536**	with H2-DM1 CPU

*So visit **www.do-moreplcs.com** for the details, watch overview videos, and download the free software to take it for a spin.*

Or go straight to:
***www.automationdirect.com/do-more-plcs** to buy!*

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Product Snapshots

Press Releases

IronHorse stainless steel general-purpose AC motors

The IronHorse™ general purpose AC motor line now includes stainless steel three-phase motors available in horsepower ranges from 0.33 to 2 hp. Motors are available in speeds of 1800 and 3600 RPM and are electrically reversible.

The three-phase industrial duty 56C-frame TEFC motors, priced from $275, feature 304 stainless steel frames and stainless steel shafts. IP56-rated, they are equipped with a large easy-to-wire junction box with fluorinated silicone rubber gasket and stainless steel cable gland. These NEMA design B motors are available with or without mounting feet and can be mounted in any orientation, horizontal or vertical, as long as the drain plugs are installed in the two lower locations. The stainless steel series is CSA-certified, and is designed for washdown applications as well as being ideal for applications such as conveyors, fans, gear reducers, and pumps.

The new IronHorse stainless steel motors are available for same-day shipping and are backed by a one-year warranty. View the IronHorse stainless steel motors at: www.automationdirect.com/stainless-ac-motors.

More ultrasonic sensor choices

Our line of ultrasonic proximity sensors now includes additional 18mm round plastic DC models. The UK1 series are IP67 rated sensors with a 15 to 30VDC operating range and are fitted with an M12 quick-disconnect. The UK1 series offers six different output types: single PNP, dual PNP, 4-20 mA only, 0-10V only, PNP and 0-10V, and PNP and 4-20 mA. Models are available in four different sensing ranges: 50-400mm, 100-900mm, 150-1,600mm, and 200-2,200mm.

The sensors are equipped with LED status indicators and a pushbutton teach feature for configuration of normally-open and normally-closed states for DC output models and for adjustable sensitivity on analog output models. Backed with a lifetime warranty, the UK1 series is cULus, CE and RoHS approved and prices start at $99. Learn more about ultrasonic sensors at: www.automationdirect.com/ultrasonic-sensors.

Safety speed monitor relays

AutomationDirect has added Dold safety speed relay modules to its line of safety products.

The BH5932 speed monitor relay module is designed to monitor two

sensor inputs that are detecting rotating targets on a motor shaft. This monitor relay features two-channel operation and can be used for standstill and over-speed monitoring of three-phase motors. When used as a standstill monitor, a switch point is set just above the "safe" or normal operating speed. When motor speed rises above this setting, the relay opens to protect against motor damage. The BH5932 relay module has an adjustable impulse-per-minute (IPM) range of 10 to 20,000 IPM, LED status indicators, two PNP sensor inputs, and two normally-open and one normally-closed positive-guided contacts. Available for 24VDC, 120VAC, and 230VAC supply voltages, prices start at $279.

The LH5946 standstill monitor relay module provides safe standstill detection on single-phase and three-phase motors (up to 690V) by monitoring remanence voltage without external sensors. The monitor relay modules are designed with broken wire detection and provide three normally-open and one normally-closed positive-guided safety contacts. Available in adjustable 20 to 400mV and 0.2 to 4V voltage response ranges, standstill monitor relay modules are equipped with LED status indicators and adjustable time delay; semiconductor outputs monitor relay state. Available for 24VDC, 120VAC, and 230VAC supply voltages, prices start at $349.

Safety speed relay modules are cULus, CE, and RoHS approved and are backed with a one-year warranty. For more information, visit: www.automationdirect.com/safety-speed-relay.

Solve noisy signal issues with high-speed optical isolators

AutomationDirect now offers high-speed optical isolators providing the versatility to solve various interface problems between an incremental encoder signal and a PLC, servo drive, or other input devices.

Ideal for use with single-ended or differential line driver encoder signals, the modules feature three complementary inputs rated for 4.5-7.5 and 12-26 VDC and frequency response up to 1 MHz.

The FC-ISO-C high-speed optical isolator module is designed with three complementary open collector outputs rated for 5-36 VDC that can be used in single-ended configurations. Optical isolation rated at 1800V separates the input signals from the outputs. This module can convert a differential line driver encoder signal to an open collector single-ended signal, or change encoder signal voltage to match receiving electronics input.

The FC-ISO-D high-speed optical isolator module is ideal for use with encoders and servo drive encoder signal inputs and outputs. The module features three differential line driver outputs rated for 5VDC, with 1800V optical isolation. The FC-ISO-D module converts single-ended encoder signals to differential line driver signals, or differential line driver encoder signals to single-ended signals. The module can also change encoder signal voltage to match receiving electronics input.

Both modules are designed with a slim-line plastic housing which includes an integral 35mm DIN rail mounting adapter, LED indication, and removable screw terminal blocks for easy installation and wiring. The modules, priced at $89, are UL508 listed and CE marked and are backed with a one-year warranty. For more information, visit: **www.automationdirect.com/signal-conditioners**.

Industrial safety gloves

AutomationDirect's lineup of wearable safety gear now includes safety gloves and sleeves. Styles available offer high levels of cut, puncture and impact resistance and are available in sizes ranging from extra-small to extra-extra large, depending on glove type.

Among styles offered, general purpose gloves feature nylon yarn construction with polyurethane coating for superb grip and excellent dexterity. Anti-static work gloves are ambidextrous and protect both your hands and product from electrostatic build-up while providing maximum dexterity.

Additional glove types available include cut-resistant styles made of steel core cut-resistant knit; certain styles feature reinforced thumb webbing stitching. Driver's glove-style electric arc-resistant gloves feature full grain goatskin leather and steel core cut-resistant lining.

Mechanic-style work gloves are form-fitting for excellent dexterity, and are fitted with cow grain leather palms and woven nylon backs. Excellent general-purpose gloves, they also feature adjustable Velcro wrist closure for proper fit.

Available puncture-resistant styles feature full palm and inside finger protection as well as impact-resistant knuckle padding.

More details regarding the full line of industrial gloves, starting at $6.75/pair, can be found at: **www.automationdirect.com/work-gloves**.

Cut-resistant protective sleeves are available in single and dual-layer styles. The ambidextrous design features a tube knit with integrated knit wrist and thumbhole. Starting at $10 for a single 18-inch sleeve, more information is available at: **www.automationdirect.com/protective-sleeves**.

Dual rod guided pneumatic air cylinders

The NITRA™ pneumatic product line now includes E-Series dual rod guided air cylinders ideal for applications that require precise alignment or have large side loads.

NITRA E-series dual rod guided pneumatic air cylinders are interchangeable with other popular brands of cylinders. The double-acting cylinders are constructed with high quality extruded aluminum housing and switch mounting tracks, dual chrome-plated

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Product Snapshots cont.

Press Releases

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stainless steel guide rods, and bronze bushings.

E-Series cylinders feature a maximum operating pressure of 142 psi and are available in eight bore sizes from 12mm to 63mm; depending on bore size, available stroke lengths range from 10mm to 250mm.

Prices for NITRA E-series dual rod guided air cylinders start at $94.

The complete line of NITRA E-series cylinders can be seen at: **www.automationdirect.com/guided-air-cylinders**.

To see the full line of NITRA pneumatic cylinder products, go to: **www.automationdirect.com/air-cylinders**.

ProSense line now includes room temperature sensors and Type T thermocouples

AutomationDirect's ProSense line of temperature sensors now includes room temperature sensors, Type T thermocouple probes, higher-range probes, Type T thermocouple wire and RTD adjustable immersion sensors.

The ProSense room temperature sensors feature a temperature sensing range of -40 to 185 degrees F, are constructed with ABS plastic ventilated covers, metal wall mounting subplates, and an internal terminal strip for wiring connections. The ambient temperature sensors can be mounted horizontally or vertically and are available in Type J thermocouple and Pt100 type RTD versions; prices start at $25.

Type T thermocouples, starting at $17.25, have been added for applications requiring lower temperature measurement. Available in attached plug and heavy-duty lead wire models, and in six, 12, and 18-inch probe lengths, the 1/8-inch diameter probes feature a temperature sensing range of -328 to 700 degrees F. Type T thermocouple extension wire is now available in 50, 100 and 200-foot lengths, starting at $15.75.

Additional Type K thermocouple probes with higher temperature measurement are now available. Fitted with Inconel Alloy 600 sheaths to protect against harsh environments, the quarter-inch diameter probes are available in six, 12 and 18-inch lengths and have a temperature sensing range of 32 to 2100 degrees F. Prices start at $33.25. View the full line of thermocouple sensors at: **www.automationdirect.com/thermocouple-sensors**.

RTD adjustable immersion sensors have also been added. With a temperature sensing range of -58 to 572 degrees F, the RTD features a 100 ohm platinum three-wire element and is spring adjustable, allowing for variable immersion depths. The integral bayonet cap makes installation quick and easy when used with a bayonet adapter or pipe clamp adapter. RTD adjustable immersion sensors are priced at $43.50. Learn more about RTD sensors at: **www.automationdirect.com/RTD-sensors**.

Additional ProSense accessories include ceramic terminal blocks, screw cover connection heads, thermowells, adjustable pipe clamp adapters and thermocouple connectors.

For more information on ProSense temperature sensors, visit: **www.automationdirect.com/temperature-sensors**.

Industrial-use data cables now available

AutomationDirect now offers high-quality, low-capacitance data cables designed with impedances specific for RS-232/422 and RS-485 communication applications in industrial environments.

The 24 AWG tinned copper conductors are constructed as twisted pairs to reduce electrical noise sensitivity and are available in one, two, or three-pair color coded constructions. Polyethylene conductor insulation provides very high insulation resistance. The rugged gray PVC jacket is durable enough for use in demanding industrial applications.

Protection from radiated or conducted electromagnetic interference is provided by combination shields consisting of an overall foil shield layer with drain wire and a woven braid shield layer. This shield combination offers maximum effectiveness across the frequency spectrum compared to other single layer shielded cables.

Data cables are backed with a one-year warranty and are available in 100-foot coils and 500 or 1,000-foot rolls, with prices starting at $69 for a 100-foot coil. For more information, visit: **www.automationdirect.com/data-cables**.

Keep those digits safe!

At AutomationDirect prices

Arc Flash & Cut Resistant Gloves
$19.00 pr.
(TTP203 Series, leather)

Puncture / Impact / Cut Resistant Gloves
$29.50 pr.
(TTP455 Series)

Industrial Work Gloves for Hand Protection

AutomationDirect now offers a variety of protective gloves for industrial or other hazardous environments. From light-weight nylon to leather or steel-core yarn, you'll find what you need for specific working tasks. Cut resistant gloves and sleeves meet the ANSI standard up to cut level 5. Most gloves are available in sizes from extra-small to 2XL.

Prices start at just $7.00 for a six-pair package of general purpose polyurethane-coated nylon gloves.

- **General Purpose Working Gloves**
- **Anti-Static Gloves**
- **Arc Flash / Cut Resistant Gloves**
- **Cut and Puncture Resistant Gloves**
- **Mechanics Style Gloves**
- **Impact / Puncture / Cut Resistant Gloves**
- **Cut Resistant Sleeves**

Cut Resistant Gloves
$7.00 pr.
(TTP050 Series, with polyurethane palm)

Also Available

- **Safety Glasses**
  starting at $2.75 (SG-754)

- **Safety Light Curtains, Relays and Switches**

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Cover Story

Reduce operating costs

Reducing Total Cost of Ownership

By Christine Lesher

Automation is a key component when developing strategies to help customers reduce their operating costs.

Many times when making buying decisions, people look only at the initial price of an item without considering other factors that contribute to the overall cost of owning that product. For example, a certain laptop may seem like a great deal—before adding the cost of the operating system and the software, and the extra memory needed to augment the unit. Moreover, the low initial price might mask the fact that the cheap laptop will become obsolete much faster than a more expensive unit, or that it may not be robust enough to withstand the rigors of travel.

This example is similar to purchasing decisions that must be made when buying an industrial machine. In addition to the initial price, expenses that may or may not occur during its service life need to be calculated to determine how much the machine will cost over its lifespan. This is called the total cost of ownership (TCO) and is a critical factor in the purchasing process of a machine, but one that is often overlooked.

In addition to the initial costs, such as the purchase price and the cost of integrating the machine or equipment into the overall control system, buyers need to consider the long-term operating costs before making a purchase. A bargain isn't a bargain if it will require unusually high amounts of energy and maintenance. Buyers must also consider additional factors in the TCO equation: downtime and changeover expenses, off-spec product, floor space requirements, insurance, financing costs, training, security and safety, among other expenses.

Unfortunately, these considerations aren't as easy to make as they are for a consumer product, such as a laptop or a smartphone. Machine builder OEMs need to realize the features that reduce customers' TCO may increase the cost of their machines. Corresponding higher prices may scare off customers, so OEMs need to decide how to best educate their customers about long-term savings in order to justify the higher purchase price.

Importance of Energy Efficiency

As energy costs continue to rise, most customers are looking for greater energy efficiency from their machines. Most of a machine's operating costs come from its energy usage, making energy efficiency an important selling point.

OEMs are responding by building more energy efficient machines. In order to improve, they need to see exactly how energy is being used by their machines. Monitoring energy consumption can provide the knowledge as to where improvements can most easily be made. In the Control Design January 2012 story "Design for TCO", Carl Henning, deputy director of PI North America (www.us.profibus.com) explains an approach to uncovering energy costs by using Profienergy, a function of Profinet. Henning says, "One of the features of Profienergy is the ability to format data into useful information about energy demand. This information can be used to avoid demand peaks."

Extending a Machine's Lifespan

Monitoring also provides valuable information beyond energy usage that may help machine builders provide better TCO for their customers, such as how to extend the life of a machine by protecting it from damage.

Embedded intelligent devices monitor motor currents, vibration and torque signatures, which help machine builders design machines with protective functions against these problems. By protecting against the damaging effects of electrical and other hazards, they can provide long-term equipment protection that extends the machine's life and reduces the frequency of equipment replacement.

Looking at Hibernation in New Ways

Including a hibernation state is a valuable approach to improving TCO by reducing operating hours and energy

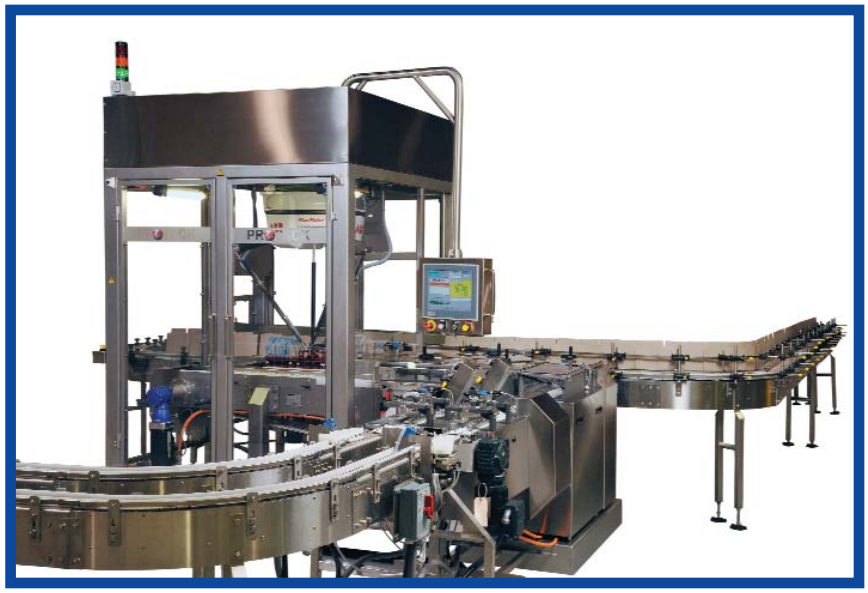

Figure 1: This Propack dual-infeed packaging machine accepts 350 granola bars per each of two sides. The bars are loaded into a single stream of top load cartons in different counts depending on retail requirements, and into bulk format cartons. (Courtesy of Control Design's "Design for TCO" article, January 2012).

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Stainless Steel AC Motors

... with IP56 environmental rating

Ready for washdown and harsh environments!

IronHorse™ Stainless Steel AC motors are designed for use in applications where motors are frequently exposed to moisture, humidity, certain chemicals or other washdown environments. *(NOT rated for direct contact with food.)* All our Ironhorse motors are in stock and ready for **same-day** shipment; if your order is over $49, you get **free shipping** too!

Also Available

- **Cast Iron Premium Efficiency motors** up to 200 hp, starting at $155

- Single-phase and three-phase **rolled steel general purpose motors** up to 2 hp, starting at $79

- Marathon **Inverter-duty AC motors** up to 100 hp, starting at $143

- **DC motors** up to 2 hp, starting at $133

Features

- **0.33 to 2 hp, three-phase**
- **1800 and 3600 RPM**
- **Standard NEMA 56C frame**
- **Available with or without mounting feet**
- **Totally enclosed, fan cooled**
- **304 stainless frame and base; 303 stainless motor shaft**
- **No restriction on mounting orientation**
- **IP66 cord grip included**

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Cover Story cont.

Reduce operating costs

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use. In the Control Design January 2012 story "Design for TCO," Derek Jones, marketing manager at Lantech (www.lantech.com) comments, "Our machines only run when product is fed to the machine. During downtime, the machine is not using much power at all."

The Control Design article also looks at how the Canadian company Propack Processing & Packaging Systems (www.propack.on.ca), which builds robotic collators to feed topload, endload and multipack packaging machines, uses hibernation to improve TCO. (*Figure 1*). Propack's machines typically run three shifts per day. Chris Follows, president, says "If no product is available, we turn off all the conveyors that feed the machine. This also ensures cartons are not damaged due to conveyor friction."

A hibernation cycle can go beyond reducing energy costs for operating the machine. By reducing the time a machine is running at full load, users also reduce the amount of heat generated throughout the operations shift, thus lowering cooling costs.

Many customers may not be aware of the machines' features that can help them save energy, such as automatic sleep mode. According to the Control Design story, a recent study in the automotive industry quantified the potential savings of putting systems into a sleep, hibernate or standby mode when not actively producing value. The analysis concluded potential savings of up to 30 percent could be achieved.

Hibernation can be a good way to reduce energy costs, but it can't be simply added without carefully reviewing how it may affect other systems within the plant. Determining how to design and implement hibernation states require careful study, such as determining when to save energy by shutting the systems down, or when it's better to leave them on.

Machine builders also need to examine the effects from the plant floor to an ERP system. One way to ensure a hibernation scheme is compatible with workflow and other production realities is to transfer I/O data to an ERP or MES.

Automation Keeps Costs Down

The calculation of reducing customers' TCO but maintaining competitive machine pricing is a careful balancing act for industrial OEMs. The latest automation technology can help these OEMs meet customer requirements without having to sacrifice their profit margins.

In the Control Design story, Howard Dittmer, vice president of engineering and technology at Arpac (www.arpac.com), maker of packaging equipment in Schiller Park, Ill. says, "Automation is a key ingredient in providing the flexibility that customers demand in our type of equipment." He adds, "Modern industrial controls allow us to produce core machine designs that we're able to customize to fit a wide range of applications." (*Figure 2*)

Figure 2: This ARBOT machine is an automated robotic palletizer and stretch wrapper, built by Arpac. Automation provides the flexibility required to cut TCO. (Courtesy of Control Design's "Design for TCO" article, January 2012).

Flexible Manufacturing

Although the features and functionality of automation technologies have been increasing significantly, their prices have remained relatively constant. This is good news for OEMs because the relative cost of automation actually is getting smaller, unlike mechanical components such as gears and linkages. Therefore, automation technology improvements are good ways for OEMs keep their costs down, while delivering better products to their customers.

The ability to develop more flexible designs is a good example of how automation helps improve TCO. "For example, if an infeed can be modified through automation to be flexible to accommodate a 12 or 16 inch opening, this can become a standard single product, rather than having a 12 in. machine design and a 16 in. machine design," explains Michael Gurney, principal at system integrator Concept Systems (www.conceptsystemsinc.com) in the Control Design story.

Reducing TCO in Existing Machines

How can TCO be lowered for existing machines in service? Upgrading the control system is one of the best ways to reduce TCO on an existing machine. It eliminates the need to replace expensive machinery, which often includes structural steel, motors, sensors, robots, conveyors and other systems.

The Control Design story takes a look at how Industrial Technology Solutions (ITS), a system integrator in Columbus, Ohio, saves customers money by updating older control

systems (***Figure 3 on page 14***). Design engineer Brian Engle says, "If the equipment is not functional, then the manufacturer isn't making money." He adds, "The advanced diagnostics and interfaces that automation can provide are, in my opinion, the best use of automation for an end user." (***See page 14 for more details on this ITS application***; ***visit Web site at:*** **www.industrialtechnologysolutions.com** ***for other applications.***)

Outdated controls often raise operating costs due to their inadequate operating efficiency, higher maintenance costs and shutdowns that affect production. For example, an OEM recently discovered the benefits of adding a motion controller to reduce costs. In this case, a plant used some high-speed valves that cycled often, and the cushions that the valves sealed against would often wear out, requiring the whole plant to be shut down while the cushions were replaced.

A motion controller was added to properly accelerate and decelerate the valves at high speed without causing impact of the valve seat at the end of stroke. This relatively simple step helped the plant eliminate the three shutdowns per year that occurred prior to the upgrade, resulting in measurable and significant cost savings and reduction in TCO.

Rethinking Mechanical Line Shafts

In addition to control systems, mechanical line shafts are also good candidates for upgrades in order to reduce TCO. One company found that replacing mechanical line shafts with individual servos greatly minimized the setup time of a machine. Its client had a food-processing machine for which each product change required up to half a day just to tweak mechanical cams of a line shaft to ensure proper timing of the machine.

By replacing the mechanical line shaft and cams with individual servos, the timing is now stored as a product recipe; it's simply recalled with the press of a button on the HMI for a product change. The increased production flexibility and reduced downtime for the customer quickly achieved payback for the slightly higher initial hardware cost. However, caution must be taken when using servos as replacements, especially if a design is optimized for a pneumatic or a cam-driven mechanism. In this scenario, costs are likely to increase rather than decrease. On the other hand, if a new design is optimized to take advantage of the functionality offered by the servos, the costs are diminished.

Another great way to reduce unscheduled and even required maintenance costs is by upgrading from older technologies like line shafts, pneumatics or chain drives to servos and steppers.

"We're upgrading a seed-packaging machine from a chain-drive system with interconnected timing gears and belts to a completely modular design using independent steppers and servo controllers from AutomationDirect for coordinated motion," Engle of ITS says. "The existing system is extremely difficult to adjust, as one adjustment leads to every other aspect of the process running at a different speed. Changing to steppers and servos will eliminate the problem."

Educating Customers

As mentioned in the beginning of the article, too many buyers only look at the initial purchase price, not all the extra costs that can turn a bargain into a money drain. Educating customers about how the initial extra cost from new technologies can help them save money over the lifetime of the machine can be a challenge for OEMs.

The first steps are to understand each customer's needs, and to then find the right solution for that customer. OEMs need to take the time to help the customer recognize how the total cost of a certain machine is more than just its purchase price. Using a customer's own numbers instead of a general estimate to show how the machine can reduce labor or maintenance costs helps them to better visualize potential savings.

Engle from ITS explains how using a customer's own data is more effective than simply giving them general figures. "If a company tracks maintenance and equipment downtime, it's fairly simple to show payback," he says. "Most manufacturers feel comfortable with numbers coming off the equipment and can schedule accordingly. They demand a solution that will provide them the ability to minimize production loss and maximize profit. This can be proven to do so through their own collected data." Lastly, it's important to note that not every customer needs every feature. Automation technology is a big factor in reducing TCO, but most clients don't need all the latest technologies. OEMs must determine which features and technologies will help their customers achieve their goals, and eliminate superfluous features. This doesn't just help to close the sale; it also helps customers achieve their specific goals, increasing the likelihood of repeat business.

Cover Story cont.

Reduce operating costs

Making Processes and Automation Easier

There are times when a perfectly good machine is replaced, when the better alternative would be to simply replace the control system. Brian Engle, design engineer at Industrial Technology Solutions (ITS) gives a good example of this when discussing a horizontal bender at a conduit manufacturer customer.

The horizontal bender required seemingly endless adjustments that dragged down productivity. It was controlled with manually operated hydraulic valves that had to be manipulated by two operators to achieve the necessary bend angle. A hard limit switch was used to control the travel of the bending die. Travel had to be adjusted constantly for variations in the pipe size and inconsistencies in the material.

The process of segment bending needed very precise control to achieve a quality product. Operators had to make several precise smaller bends while moving the pipe forward in the shoe. In addition to a long setup time, an enormous amount of scrap was produced before good product could roll off.

"If a job calls for, say, making 90 degree elbows with a 60 inch radius from 2 inch galvanized rigid conduit, there is no standard shoe for that. So this machine is used to make small quantities of non-standard products," explains Engle.

Instead of sticking with the cumbersome old process, the manufacturer asked ITS to modernize the control system with an HMI, PLC and sensors from AutomationDirect. (***Figure 3***)

"The new system uses a magnetic encoder on the bending die to track bend angle while analyzing the bending shoe to compensate for pipe inconsistency and spring back," Engle explains. "A linear cable position encoder allows the bending shoe to measure pressure or positioning sensing."

The new HMI is an integral part of the process as the gateway for the operators to interface with the PLC. Maximum product output is now achieved as a result of the system's advanced diagnostics that shorten downtime and optimize setup procedures. The manufacturer can measure the improvement in TCO directly in terms of reduced scrap, quicker turnaround on custom jobs, and reduced labor for setup and operation.

ITS understands the goal of automation is to make work easier for the user. "Troubleshooting a machine can be a daunting task for most plant personnel. We try not to overcomplicate that process with unnecessary sophistication. When the situation demands it, a more complex control system can be implemented and easily justified by its advanced diagnostics and intuitive interfacing techniques."

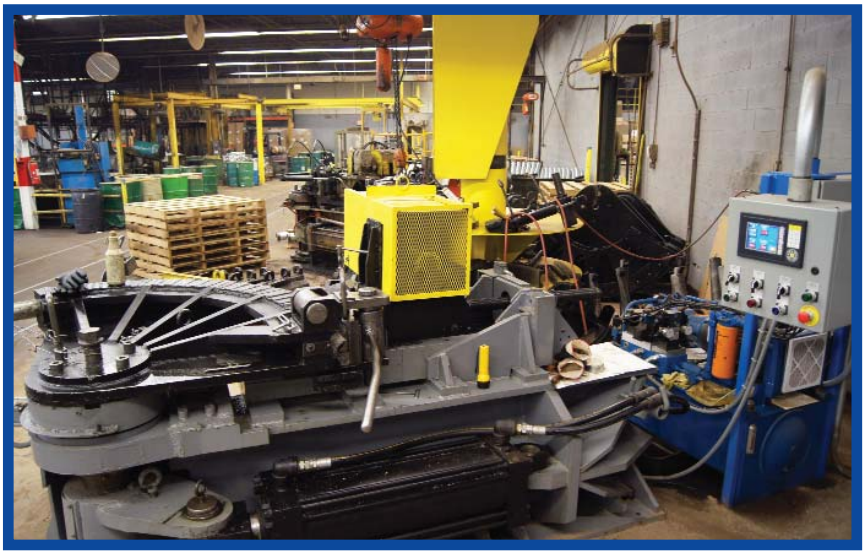

Figure 3: ITS was able to modernize this horizontal bender machine using solutions from AutomationDirect, including the PLC, HMI and sensors, as well as steppers and servo controllers for coordinated motion.

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Product Management Corner

what is a do-more PLC?

By Sammy Natsui
PLC Product Manager,
AutomationDirect

At 9:14AM on September 6, 2012, AutomationDirect released the new Do-more PLC. Many customers already knew that Host Engineering, the developer of the Do-more PLC, had been working on this next-generation CPU for several years. Here are some observations from a personal perspective.

What is Do-more?

If you have ever used a *Direct*LOGIC PLC, you probably know Host Engineering - they developed the programming software *Direct*SOFT, and also specialty modules such as the Ethernet communication modules and the high-speed I/O modules. *Direct*SOFT was the first Windows-based programming software for PLCs, and has served its purpose well over many years. However, the engineers at Host had a dream - to develop a completely new control engine that could take advantage of current technology. The Do-more PLC is their accomplishment.

We named it "Do-more"

To tell the truth, it was not an easy job for us to come up with a name. The naming process was fun in the beginning, and we came up with more than 100 possible names. However, it eventually became a daunting job – some people like a name, and of course, others don't. In the end, we came up with this simple name that conveys a message. "Do-more" is what you can expect with this new PLC.

Do-more Designer

I have been using the programming software Do-more Designer daily during the development and through the release. And as the *Direct*LOGIC product manager, I also use *Direct*SOFT almost daily. I have to admit I feel more comfortable using Do-more Designer. This is because of features that help the processes of creating, editing and troubleshooting the ladder program, such as the Project Browser and the Trend View. The software Help file covers all the information you need to write your program. I refer to the Do-more PLC user manual only when I need to set up the jumper switches in the analog I/O modules or wire the H2-CTRIO(2) modules. If you spend some time with Do-more Designer, you'll see what I mean.

Do-more instruction set

The Do-more instruction set was newly designed for the Do-more PLC. We understand it can often be time consuming and painful to learn a new instruction set. We could have just added some new functions to the *Direct*LOGIC instruction set to extend its capability, but that would ultimately have been limiting. Do-more has 172 instructions, many of which can replace dozens of lines of *Direct*LOGIC code for a similar task. I use the Instruction Palette to find what I need.

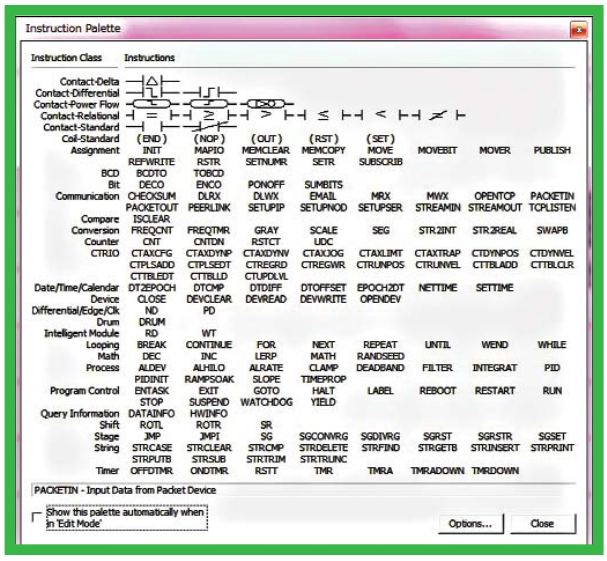

Figure 1: Instruction Palette

Spend less, Do-more

Have you watched the overview video of the Do-more PLC? (The link is available at www.do-moreplcs.com.) Because the Do-more PLC has more features and better performance in comparison to the current DL205 CPUs, we could have positioned it as such price-wise. However, the engineers at Host Engineering had low cost as a design goal, and as a result, AutomationDirect can offer the modules at very attractive prices.

Future of Do-more PLC

The reason Host Engineering chose the DL205 hardware as the platform for the first Do-more PLC is because it was faster to release by using readily available and time-tested I/O and base units. However, we know that using the existing *Direct*LOGIC hardware limits the performance of the Do-more PLC for the future; we are developing ideas to create new hardware platforms that will maximize performance that the Do-more PLC can provide.

Conclusion

You don't need to replace your existing DL205 PLC system with this Do-more PLC. We will keep selling the DL205 PLC as long as we can; after all, we are still selling the DL305 PLC after almost 30 years on the market. What we hope is that you will try the Do-more PLC for applications that you have never been able to do with our other PLC products because of missing features and/or performance. With this new PLC, you will find you can Do-more.

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Feature Story

American Label & Tag

Bringing Life to an Old Machine

An innovative employee at American Label & Tag was an automation neophyte, but AutomationDirect's customer support showed him the way.

By Christine Lesher

American Label & Tag was incorporated in 1988 and is based in Canton, Mich. The company's original mission was to produce high quality pressure sensitive labels. After expanding into the tag market in 1997, the company moved into its current custom-built facility in Canton, Mich.

Today, American Label & Tag services the digital print-on-demand market, using its capabilities to produce all required artwork, graphics, design and plate making. In addition, the company is a national distributor of printers, software, bar coding systems and accessories. The company sells labels and tags nationally and internationally.

American Label & Tag prides itself on having team members who are problem solvers, not just order takers. The company is a great representation of American manufacturing, and its maintenance supervisor Bill Dobiesz is an equally great example of American ingenuity.

When Dobiesz started working at the company's Canton plant in October 2003, there were four Markem LP-195 hot stamp presses at the facility, but only one was operational. The machines were no longer being supported by the manufacturer, so over the years three of the machines had been cannibalized for parts.

Many readers will recognize aspects of Dobiesz' personality in themselves; he was the kid who would take apart the vacuum cleaner and the telephone to figure out how they worked. His mechanical inclination led him to the career he has today, in which his spirit of learning how things work has made him a valuable asset to the company.

Not content to see the machines sitting idle, Dobiesz devoted extensive time and effort, including making some parts on his own, to get two of the forgotten machines operational. It was a project he did largely on his own time and with his own money, as he couldn't resist the challenge. During the project, he got to know the machines pretty well from the inside out. He knew they were high quality hot stamp presses, and he was determined that the problem of unavailable replacement parts wouldn't stop him.

Taking on New Challenges

The economic downturn in 2008 affected many companies, and American Label & Tag was no exception. Fortunately, American Label & Tag has a very hands-on owner who is involved in the business at every level. He knew he had many good employees who would be willing to learn other job duties to help the company through the recession. Dobiesz thought that he could get the hot stamp presses running again, so he volunteered to work on them.

At one point he told Tim Gleason, president of American Label & Tag, he wished he hadn't taken the other Markem LP-195 machine to Florida because he thought he could get it running. Gleason had faith in him, because one phone call and two days later, the machine arrived back in Michigan. But, Dobiesz thought he might have made a big mistake when he saw the state of the machine.

The Markem LP-195 hot stamp press when it arrived back in Michigan, in dire need of attention.

Dobiesz had to learn how the machine worked on his own because the operational sister machine was at the company's other plant in Daytona Beach, Fla. Moreover, two of the items that had been stripped for use in the other machine were the control switchboard and the electromechanical counter, basically the machine's entire automation system. The electromechanical counter was still available, but it was expensive and limited in functionality.

Searching for a better solution, Dobiesz saw a magazine ad for the CLICK PLC from AutomationDirect. Confident in his abilities, he used his own money to buy the PLC and a power supply. He was able to do this because the CLICK PLC was very economically priced, and because the downloadable programming software was free.

Small Size, Big Performance

In addition to its low price and long list of capabilities, the CLICK PLC was very small. Unlike any of other printing machines at the company, this one had all the controls in a removable drawer. Installing the new PLC anywhere but in this drawer would have presented problems, and the CLICK PLC's small size made this option a reality.

The CLICK PLC fits easily into the removable "drawer" where it had to be installed.

After purchasing the CLICK PLC, Dobiesz realized he'd also need to provide an operator interface for the machine, so he naturally turned to

AutomationDirect and bought a *C-more* Micro-Graphic touch panel with a three-inch display. Using the PLC and the touchscreen, he found he could now exceed the original capabilities of the machine for less money than it would cost to restore the original functionality.

The original mechanical predetermining counter had a maximum count of 99,999. It would count every stroke and would stop at the preset, which had to be a value less than or equal to 99,999. This reduced the efficiency of operation, as it's not unusual to have jobs of 120,000 to 300,000 copies. With the CLICK PLC and the touchscreen, the machine is now capable of counting to 9,999,999.

Dobiesz also added a counter stop switch that enables the machine to operate without advancing the count, as well as a counter bypass switch that enables the machine to continue to operate in excess of its predetermined count.

New Functionality Added with Ease

Thanks to the large amount of program memory space in both in the PLC and the touchscreen, Dobiesz was able to add needed functionality via screens, counters, timers and more—all at no additional hardware or software cost.

"As long as I have inputs and outputs for connections, my imagination is the only limit to what I can do. If adding additional software-programmable switches, time delays or control relays add needed functionality—I just update the program, load it and I'm running," says Dobiesz.

He has set up the ability to change the screen color when the predetermined count is reached, when any of the bypass functions are enabled, or if guards are opened. In addition, the touchscreen beeps if a guard is opened, an emergency stop is pushed, or if the preset is reached.

By operating the other machines, Dobiesz learned the best way to reset the counter was by having it appear on another screen. Using this method, the counter is easy to reset, but requires a deliberate action to avoid mistakenly resetting it in the middle of a job.

He was also able to use the touchscreen to add a shift counter that an operator can reset to show how many jobs have been done in a shift, a week, a month, or any other time period. In addition, Dobiesz also created a single cycle function, similar to jog, that allows the machine to execute one cycle, then stop, which is used to save materials during setup.

One feature of which he is particularly proud is the "mini batch" counter. An operator can set this counter so that the machine executes a certain number of cycles, then stops. This gives the operator time to clear the machine and stack parts before pressing the start but ton for the next mini batch. The mini-batch counter functions within the main counter, so the machine is still keeping track of the total batch count.

Using Dobiesz' solution, it's possible to retrofit the entire automation system of any existing Markem LP-195 or LP-385 machine with a low cost, high performing and reliable AutomationDirect control system consisting of a CLICK PLC and a *C-more* Micro-Graphic touch panel.

The Markem LP-195 hot stamp press today after Dobiesz' retrofitting of the automation system.

Great Help from Real Users

As the CLICK PLC and the *C-more* touchscreen were new to Dobiesz, he needed assistance with many tasks, from basic installation practices to programming. He found AutomationDirect's Customer Forum to be a great help, as he could discuss his situation with other users who would walk him through solutions in real-time online.

"The AutomationDirect Customer Forum is one of the biggest and best user groups in the automation world," says Dobiesz. "There were helpful replies from the AutomationDirect tech people, to be sure—but the ground zero, hold-my-hand-and-walk-me-through-it advice I needed was from other forum members. I'm happy to share my information with others, I'm known as DetroitSound. Maybe I can help someone who is struggling as I was, so that they too can get the personal triumph of solving a problem of their own," offers Dobiesz.

As Dobiesz was now familiar with the CLICK PLC and *C-more* touchscreen, he decided to use these components on weekend project, namely an older washing machine in his house that was no longer running. The electronic timer failed, and the parts were no longer available. Dobiesz was able to use the programming experience he gained from the hot stamp printing machines to fix his own washing machine, and it ran several more years until it developed mechanical issues.

Dobiesz reprogrammed the *C-more* touchscreen he had bought for the washing machine, and he now uses it as a detachable testing device for his other projects at the plant. He says that he's been able to successfully complete many projects because of the economical prices AutomationDirect offers, and because of the Customer Forum where he knows he can always quickly get any assistance he needs.

User Solutions

VIKINGRange

PLCs Automate Reliability Testing

AutomationDirect PLCs enable continuous life-cycle testing, provide data collection, and shorten product design and verification cycles at Viking Range.

By Barry Hupp, Reliability Manager, Viking Range, Greenwood, Miss.

When Fred Carl, Jr. was designing his house in the early 1980s, he wasn't satisfied with the quality of available ranges. He came up with his own range design, and soon thereafter launched Viking Range (www.vikingrange.com). Viking Range was established on Carl's requirements for high reliability and quality, a mandate that has been carried forward ever since.

Although contract manufacturers in California and then Tennessee made early Viking Range products, all production moved in-house to our Greenwood, Miss. facility in 1990. In-house manufacturing enabled our company to provide higher quality and greater reliability, but we wanted to improve further, and saw automated testing as a means to that end. (*Figure 1*)

Why Automate Product Testing?

The dishwasher lab and the cooking and refrigeration lab are our two main reliability test labs. We started the dishwasher lab in 2003 and the cooking and refrigeration reliability lab in late 2005.

Before we created the labs, product engineering did their own testing. At that time, product engineers weren't using PLCs, and testing products manually was burdensome, so we needed to build several automated test stands for testing components to be used in dishwasher designs.

By automating the test labs, we aimed to reach several goals as outlined in *Table 1*. We needed to standardize test procedures to facilitate compliance with industry standards, and to improve product testing in general. We wanted to cut test time, and to reduce labor requirements. Automatic recording of test data was another goal, as this would allow analysis and improvement of test procedures. Finally, better test data would enable us to improve our product designs.

To reach these goals, we began using PLCs for reliability test stands. An electronics engineer working on dishwasher products suggested using *Direct*LOGIC DL06 PLCs from AutomationDirect.

We found that the AutomationDirect PLCs were simple to use, economical to purchase, and that they could measure everything we needed to test the dishwasher components. When the time came to build more test stands as well as start the cooking and refrigeration lab, we turned to AutomationDirect.

We continue to use AutomationDirect DL05 and DL06 PLCs in our test labs. We use both AC input and DC input versions of both PLC models. Other modules we use include thermocouple input and 0-10 VDC analog input. We typically don't use analog or solid state outputs, but use relay outputs instead.

Other AutomationDirect products we use include *C-more* 3-inch Micro-Graphic touch panel HMIs, *Direct*SOFT5 PLC programming software, and KEPDirect OPC software.

Washing our Hands of Manual Test

In 2003, the design of a new dishwasher product started Viking range on an evolutionary path toward creating reliability test labs and using PLCs to automate test-stand operation.

Figure 1: Automated testing of products like this range enables Viking Range to provide high quality products with superior reliability to their demanding customer base.

Why Automate Product Tests?

1.	Standardizes test procedures
2.	Facilities compliance with industry standards
3.	Cuts test time
4.	Reduces labor requirements
5.	Automatically records test data
6.	Allows analysis and improvement of test procedures
7.	Enables improved product design

Table 1: Reasons to automate product tests

The chief engineer on the dishwasher project wanted the major components tested to ensure a statistically high level of reliability.

We created, designed, and built six test stands to ensure dishwasher components exceeded Association of Home Appliance Manufacturers (AHAM) and Viking Range standards for long-term reliability. AHAM is an ANSI-accredited standards development organization that develops and maintains technical standards for various appliances to provide uniform, repeatable procedures for measuring specific product characteristics and performance features.

The components to be tested were dishwasher motors, drain pumps, water valves, soap dispensers, water heaters, and heaters/blowers for drying the dishes. We built a separate test stand or fixture for each of these part/component types, and each of the six test fixtures had the capacity to test 22 components. A DL06 PLC controlled each test fixture except for the water valve test fixture which used a DL05 PLC.

We built the test fixtures to simulate how these components would be used in a dishwasher. For example, a water valve may come on for 70 seconds to put water into the dishwasher five times during a wash cycle. We used a PLC to control the timing cycle. When temperature or current measurements were required, we simply added an analog input module.

Over the years, we've changed the test fixtures and PLC configurations to accommodate our reliability testing requirements. Today, we still use part of the original dishwasher test lab, but instead of the DL06 PLCs we started with, we use three DL05 PLCs. These PLCs are mounted on custom stands that test individual dishwasher parts such as soap dispensers and pump and drain motors.

Other dishwasher life testing tasks we've added include a door cycle fixture for opening and closing a dishwasher door from 30,000 to 50,000 times (*Figure 2*); an upper slide rack fixture that tests a dishwasher's upper rack by sliding it in and out; and a fixture that tests dishwasher water valves by cycling them on and off repeatedly.

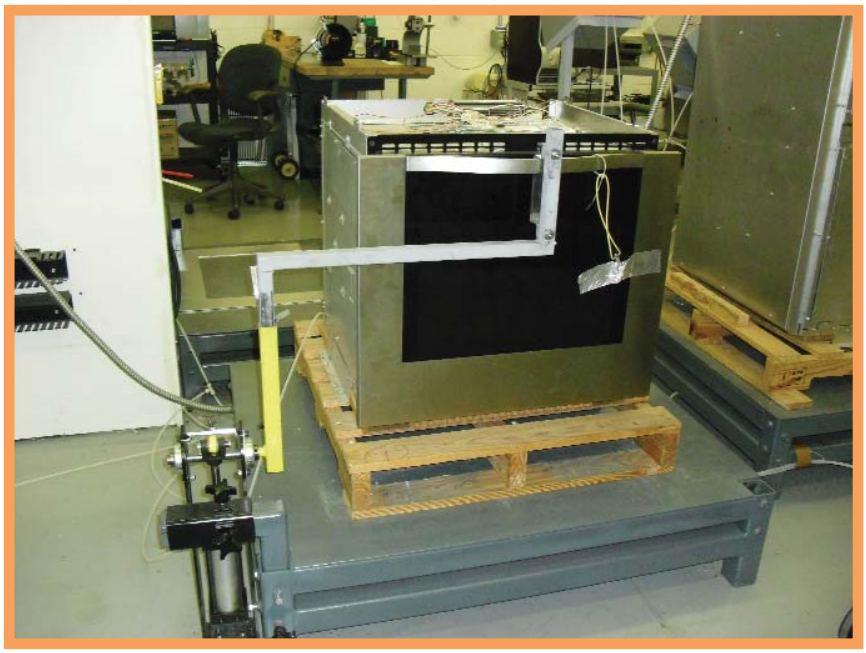

Figure 2: This custom door cycle fixture performs life testing by opening and closing a wall oven door up to 50,000 times, depending on test requirements.

The primary dishwasher test lab has four dishwasher life test racks with 16 test stations for each rack. A test station is where testing of an individual product such as a dishwasher takes place, whereas a rack consists of multiple test stations grouped together.

Dishwasher design engineering uses two of the four racks in the dishwasher test lab, and reliability engineering uses the other two. Each of the four racks has a DL06 PLC, and the two reliability engineering racks each have an additional DL06 PLC.

The tasks performed by each of the four DL06s include keeping track of the number of completed cycles for each dishwasher; monitoring the test rack drain pump safety circuit; staggering dishwasher start delays when lost utility/facility power is restored; and energizing soap injection pumps at the start of each main wash cycle.

The PLC for each rack receives a signal from each dishwasher at the beginning of the main wash cycle. The PLC subsequently energizes a small pump, which injects the appropriate amount of soap into the dishwasher. There are 16 DC pumps for each rack, one for each dishwasher. These pumps are external to the dishwashers as they are components of the test racks.

The two additional DL06 PLCs control the two test racks that belong to reliability engineering, and control air cylinders that push dishwasher cycle and start buttons. The relay outputs of the PLCs operate air control valves, which, in turn, operate the air cylinders.

To operate a Viking Range dishwasher, users must push control panel buttons while the door is open. We designed the dishwasher test stands with relays that simulate opening the door. We use small 4-inch air cylinders that physically push the wash cycle and start buttons. The air cylinders are positioned at the top of the dishwashers at each test position.

Tests start every 2.5 hours, and continue to loop 24/7. Dishwasher current draw and power consumption are monitored using AC voltage and current transducers connected to an industrial PC.

Continued, p. 22>>

User Solutions Cont.

VIKINGRange

Continued from, p. 21

Cooking and Refrigeration Test Runs Hot and Cold

The main reliability lab—also known as the cooking and refrigeration test lab—is our largest testing facility. Here, we test ranges, wall ovens, cook tops, refrigerators, ice makers, and compactors. Our cooking and refrigeration test lab uses more PLCs than the other labs, with most of them monitoring range temperatures.

The DL06 PLCs operate test stands and control cycle times. For example, cycle times for ranges can be 30 minutes on and 10 minutes off for 6,000 cycles. Range and wall oven doors receive rigorous workouts as well. In the cooking and refrigeration test lab, two test stands, each with a DL05 and ***C-more*** HMI, operate and monitor the range and wall oven door open-and-close cycles. The HMIs display the cycle counts, while the touch screen keyboard allows test engineers to reset the count.

Some of the DL06 PLCs are configured to measure current draw of electric ranges and cook tops. AC current transducers measure the current usage monitored by the PLCs and collect data for graphing this current.

DL06 PLCs measure temperatures of ranges, ovens, and cook tops under test. Thermocouples are attached to analog inputs cards. The PLCs are programmed to run repetitive cycles that turn units on for an hour then off for 15 minutes, for example. We log the monitored temperature data in Excel, with communications between each PLC and our three PCs via KEPDirect OPC software.

OPC communications provides us with an easy way to transfer data using standard protocols. We quickly learned how to use the OPC/DDE server to collect data, and to write or modify macros in Excel to graph the collected data. Daily graphs show dips in the oven temperatures if there are issues or failures. This functionality allows us to run our tests continually, reducing total project testing time.

We use RS-232 or Ethernet for these PLC-PC connections. We use four industrial PCs and three laptop PCs in the cooking and refrigeration test lab to log test data and to write test programs and profiles that run on the PLCs. We also use these PCs as HMIs.

We use ***Direct***SOFT5 Windows-based PLC programming software to write or modify the test programs used to test appliances or component parts. For example, we recently created a program that tests three gas ranges in bake mode. The program repeatedly turns the ranges on for 30 minutes and off for 10 minutes.

Results Verify Expected Benefits

We've found the AutomationDirect PLCs to be simple to use, affordable, flexible, and highly reliable. Without much in the way of prior experience, we were able to learn how to program the PLCs in ladder logic programming using the product manuals and the AutomationDirect Web site. We found both the manuals and the Web site content to be very well-written and easy to follow.

The optional analog input cards and the OPC communications to our PCs running Excel allow us to measure temperature and current without having to buy separate and expensive data loggers. The availability of both serial and Ethernet communication ports on the PLCs facilitated the required PLC-to-PC connectivity.

The PLCs have enabled us to set up continuous component and product testing. We've been running these types of tests for more than seven years without any problems from AutomationDirect products. Due to our success with AutomationDirect products, Viking Range now uses DL05 and DL06 PLCs in two other manufacturing plants for monitoring and testing products.

"Faith is taking the first step even when you don't see the whole staircase."

– Martin Luther King, Jr.

"I don't paint things. I only paint the difference between things."

– Henri Matisse

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System Integrator Corner

KCC Software

AutomationDirect is proud to have a network of system integrators covering a wide variety of industrial control processes across the country.

KCC Software, in Huntsville, Alabama, provides services in all areas of the United States and in several countries around the world.

Tim Roberts, Integrator Coordinator for AutomationDirect, recently talked with KCC Software owner and founder, Scott Martin, to learn more of what he and his company have to offer.

How did you get started in your Controls/Engineering career?

I moved from programming Space Station automation to a mechanical systems department of my employer. This introduced me to the world of control systems in the semiconductor industry. I entered as a programmer and quickly fell in love with the bigger picture of systems integration with programming being my "specialty".

How long have you been doing Systems Integration work?

I started this work in 1986 and have been fully immersed ever since – 26+ years now. Now, at least 25% of systems I develop and deliver involve replacing 1980s and 1990s microprocessor systems with PLCs.

What was the most interesting application in which you have used PLCs from AutomationDirect?

For IBM's Watson Research Center, I developed the Silane distribution system. Silane is a volatile gas that ignites when exposed to atmosphere. Storing it under significant pressure and distributing it through the center

Silane distribution system for IBM's Watson Research Center

comprises a true challenge. Everything has to be controlled and monitored continuously throughout the facility in order to avoid catastrophic possibilities.

The solution included a series of *Direct*LOGIC DL 205 PLCs networked and in constant communication to share the task of safe gas containment and delivery. In addition to networked PLCs, the project also used *C-more* HMI panels throughout the facility and in research labs, as well as a PC-based Think & Do system for site-wide status monitoring and alarm and event historical logging.

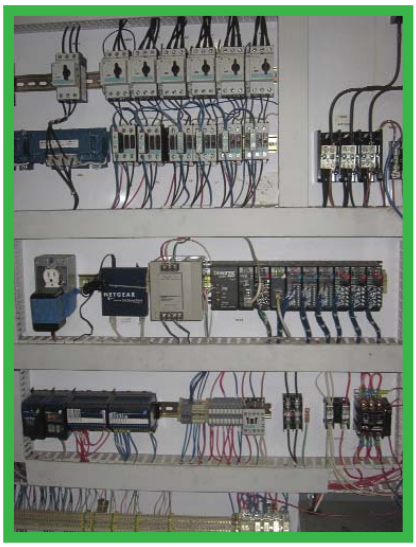
What made that project unique/challenging?

The gas delivery covers hundreds of feet of monitored tubing with potentially fast-acting pressure and temperature changes that have to be controlled for the safety of all concerned. Due to the high pressures and flammable nature of the gas involved, the constant communication between PLCs for shared control was challenging – not only for what had to happen normally, but also for what had to happen when anything unexpected occurred.

What is a favorite aspect of integration to you?

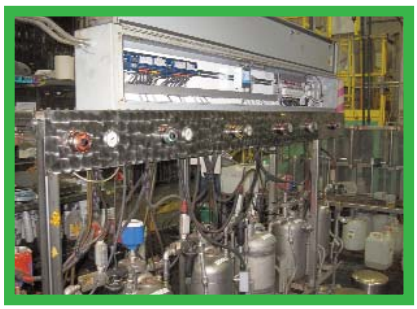
Variety – every project is different. Each industry has its own challenges. Each task of the system requires unique skills. From designing to programming to assembly to commissioning – the variety keeps each day exciting.

What was the most difficult programming (or engineering) project you ever tackled using PLCs from AutomationDirect?



Maples Rugs DirectLOGIC DL 205 control system for high-speed dye application

For Maples Rugs, I developed a *Direct*LOGIC DL 205 controlled high-speed dye application process that sprayed six different colors of dye into yarn as it sped through the machine at 1200 feet per minute. The dye had to be sprayed in 0.0125 tolerances to apply the pattern desired. The spray controls continually monitor the yarn tension and speed and adjust to fluctuations in real-time.



Maples Rugs high-speed dye application

In addition to the dye application control system, I developed a desktop pattern design application allowing the client's design department to create the

rug designs. An interpretation of this pattern was then converted and downloaded into the control system to apply the design exactly as desired. The obstacles included getting the pattern concept into the DL 205 PLC and adjusting in real-time as the speeds and tensions of the yarn strands changed.

How did you overcome the obstacles?

The obstacle of getting a concept to a pattern and then into the PLC as a series of actions was accomplished through .Net programming. This ability to program at multiple levels (PC, PLC) is one of the advantages offered by KCC Software. The timing issues related to adjusting the spray application based on real-time tension and speed fluctuations was accomplished through a central timing algorithm that drove the dye application. Both major obstacles were overcome through well-designed algorithms.

Maples Rugs high-speed dye application monitoring screen

Tell about a 'breakthrough' moment for you in your approach to control system applications.

Prior to 2000, all of my programming was in C and in both embedded and PC-based applications. Around 2001, I saw a PLCDirect catalog with a new DL06 PLC on the cover.

I immediately saw how combining PC-based programming with the PLC integration would help me provide better and more robust solutions for my clients. The low-cost, yet powerful and capable, entry into the PLC/integration business has served my clients and my business very well, Without AutomationDirect, this likely never would have happened.

To learn more about what KCC Software has to offer, visit: **www.kccsoftware.com**.

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– Steve Jobs

"A man always has two reasons for doing anything: a good reason and the real reason."

– J. P. Morgan

Tech Brief

Do-more PLC & H2-CTRIO2

Ease of Motion with Do-more PLC and the H2-CTRIO2

By Jason Horine

Part of the vision for the Do-more PLC control engine was to make maximum use of Host Engineering's next generation High Speed Counter and Pulse Output module, the H2-CTRIO2. Pairing this new module with a Do-more CPU creates a solid motion control package that is easier to use than its predecessors while offering more flexible options and capabilities.

Background

H2-CTRIO: capable, but limited by *Direct*LOGIC's architecture

The previous H2-CTRIO module brought high speed counting and pulse output capabilities to the *Direct*LOGIC PLC line. The H2-CTRIO took on the processing of these functions within the module, and as a result had its own configuration tool and files to save and load.

Since the CPU lacked the ability to assist with these tasks, the package was somewhat limited in scope, but the combination satisfied many basic motion applications.

A better way

While developing the Do-more CPUs and the H2-CTRIO2, Host Engineering took ownership of developing a new solution. Having designed the programming software, CPUs and H2-CTRIO2 from the beginning to work in concert, the overall experience is vastly improved, especially writing the application program.

Basics of Do-more with H2-CTRIO2

New hardware outperforms the previous CTRIO, but the specs aren't the biggest change.

Comparing the specifications of the H2-CTRIO2 to its predecessor shows some obvious improvements, but only begins to tell the story. The H2-CTRIO2 inputs are 2.5 times faster and the outputs are 10 times faster, at 250kHz and 250kHz respectively.

However, the most significant changes aren't in the specs, they're in how this unit works with Do-more to simplify and expand motion control capabilities.

The H2-CTRIO2 module is loaded with features which help simplify motion control, such as axis mode instructions.

Axis Mode

To greatly simplify tying ladder logic to the desired motion, the new Axis Mode instructions were designed to provide an intuitive interface for commanding moves from the H2-CTRIO2.

After configuring the I/O of the module, you drop in a CTAXCFG (Axis Mode Configuration) ladder instruction to define the limits of maximum speed, start speed, acceleration and deceleration rates. Optionally, you can pick an encoder to use for feedback and configure it.

Once an output is in Axis Mode, use any of the Axis Mode instructions to control the stepper:

CTAXLIMT (Axis Mode Limit) to home the axis

CTAXJOG (Axis Mode Jog) to manually jog

CTAXTRAP to make one move

CTAXDYNP (Axis Mode Dynamic Position) puts the axis in a mode in which it accepts new position commands as quickly as you can generate them. The output will follow the Axis Configuration parameters and immediately head toward a new target.

CTAXDYNV (Axis Mode Dynamic Velocity) puts the axis in a mode to accept new velocity commands as quickly as you can generate them.

When a servo is too much and a stepper isn't quite enough, simple closed loop control might do the trick

To bridge the gap between stepper control and a servo, Do-more and the H2-CTRIO2 offer integrated Encoder Feedback. It's part of the CTAXCFG (Axis Mode Configuration) ladder instruction.

Specify an encoder to use for feedback, choose Scaling and Deadband, and your stepper/encoder just became a closed loop system. However, a servo can detect a stalled motor, and additional code would be needed if your system requires this notification.

Once configured for Encoder Feedback, the other Axis Mode instructions are used to command moves using units of the encoder. More on that follows.

Easier programming, commissioning, maintenance

To ease programming and maintenance, the H2-CTRIO2 configuration is part of the CPU's project. The Do-more CPU configures the module for you, which is handy during commissioning. This greatly simplifies the task of replacing a module; just set the jumpers to match the original and swap the units.

The configuration tells the H2-CTRIO2 whether to expect encoders or discrete devices, such as limit switches or proximity sensors on its inputs; it also defines whether to use outputs for a stepper, as slaves to a PLS or Preset Table or as discretes accessible by the ladder program; it can also define preset tables or PLS tables, or configure timers.

Easily step through a sequence of moves using Stage programming

To easily command a sequence of moves, all the motion instructions now include Stage control. Since Stage programming works well for sequential processes and moves tend to be

sequential, the motion instructions can make stage transitions as they complete. As a result, some programs to control motion can be surprisingly short.

Integrated Programmable Limit Switch

To improve upon the precise output control offered by Preset Tables in the H2-CTRIO, the H2-CTRIO2 adds integrated Programmable Limit Switch (PLS) functionality. Where events in the Preset Tables had to occur in a specific sequence, events in a PLS occur based solely on the input counts.

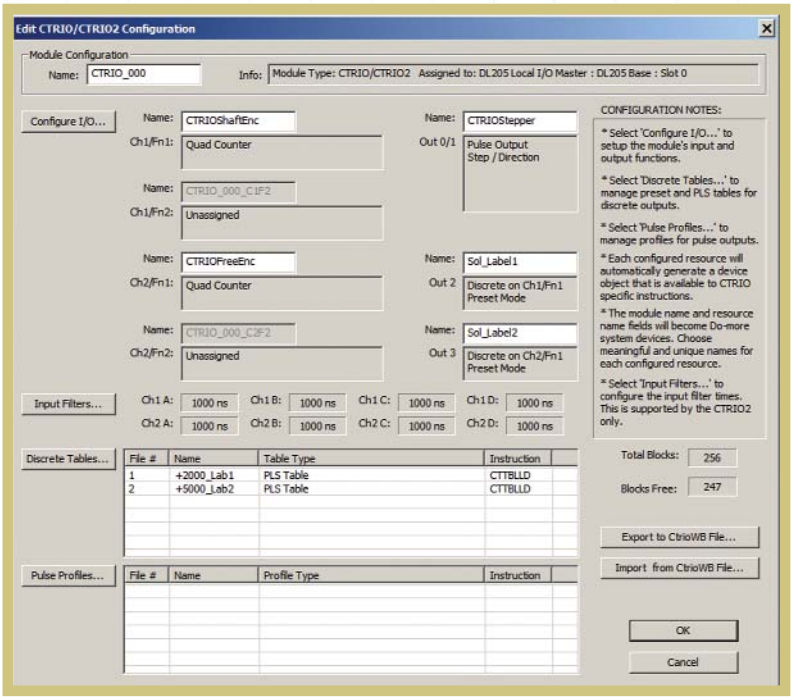
Furthermore, PLS entries and Preset Table entries can be added, edited, or deleted using several new intuitive ladder instructions in the Do-more CPUs.

More easily set up the machine using Axis mode/jog

To simplify machine setup, the JOG command makes manual adjustments to position very simple. And, to complement the new PLS functionality, two ladder instructions assist in dynamically editing any PLS from the ladder program. If a PLS will always be dynamic, simply create a blank PLS in the configuration and push values to it from a table in your program as it executes.

Summary

We continually strive to improve our products and value your opinion. For additional information on these features and more, and to download the free Do-more Designer software which introduces a powerful, intuitive set of programming tools, visit the Do-more PLC Web site at:
www.domoreplcs.com.



This H2-CTRIO2 Module Configuration summary page shows four channels configured to accept signals from two quadrature encoders; two output channels configured to control a stepper motor; and two other output channels configured to activate based on PLS table events referenced to the quadrature encoders.

"An archaeologist is the best husband a woman can have. The older she gets the more interested he is in her."

– Agatha Christie

"You are never too old to set another goal or to dream a new dream."

– C. S. Lewis

"He that would live in peace and at ease must not speak all he knows or all he sees."

– Benjamin Franklin

Student Spotlight

Jet Engine Club

Gas Turbine repurposed with PLCs

By William Rossey
Midwest Propulsion Group

The Midwest Propulsion Group is a jet engine club dedicated to increasing the engineering knowledge and experience base of students by providing real-world engineering tasks related to gas turbine restoration and performance analysis, as well as finding vehicular applications for such engines.

Comprised of students and professional engineers from the Cincinnati/Dayton area and engineering co-ops from varying universities, the group meets weekly to increase hands-on knowledge of younger engineers while having fun and also promoting engineering at local high-schools and aerospace venues.

The team is currently using *Direct*LOGIC programmable logic controllers (PLCs) to automate the starting sequence of gas turbine engines, as well as monitor performance to ensure the engines are operating within established parameters. If the engines operate outside the desired envelope, the PLCs terminate the operation automatically and display the appropriate programmed fault.

Part I: The Solar T62T-32A Hydro mechanical Engine

The Solar T62T-32A gas turbine engine was originally installed in a military generator set which included appropriate controls to start up and run the engine to provide desired electrical power.

The gas turbine runs at approximately 60,000 RPM and was geared down through a planetary gearbox to 6,000 RPM, which then drove a 3-phase, 60kW AC generator.

The controls needed to be redesigned since the original controls were not available and the intended application changed. A view of the gas turbine removed from the generator is shown in *Figure 1*.

Figure 1: Solar T62

The engine start-up operational sequence follows:

1) When the system is powered up, the transfer pump is turned on.
2) Once the "start" command is initiated, the electric starter and igniter turn on simultaneously.
3) At 4% engine speed, a single fuel nozzle is opened (torch nozzle) and combustion begins.
4) When the engine accelerates to 10% speed, the fuel manifold is opened with six fuel nozzles (main fuel).
5) Once the engine reaches 78% speed, the starter and igniter disengage; the engine speed keeps accelerating on its own power.
6) At 96% speed, the torch nozzle is disengaged and the engine continues running at 100%, which corresponds to a frequency of 2,000 Hz on the magnetic pick-up.

The original generator configuration monitored the oil pressure, exhaust gas temperature (EGT), and speed. If any of the parameters exceeded established limits, such as a loss of oil pressure or the engine got too hot, the engine would shut down.

The engine has hydro-mechanical controls, which means that the fuel scheduling is based on mechanical inputs. The fuel control/pump is gear-driven and fuel is scheduled based on engine speed and compressor pressure. In addition, to maintain constant engine speed as a function of varying load, a governor watches engine speed (frequency) and outputs voltage to the torque control motor (i.e. throttle) which is also connected to the fuel controller.

The team modified the engine controls by using a *Direct*LOGIC D0-05DR-D PLC with an F0-04AD-2 analog input module and a six-inch *C-more* (model EA7-T6C) touchscreen HMI display. The PLC controls the start sequence by engaging and disengaging accessories as a function of engine speed, while the input module monitors how well the engine starts and continues running; different parameters are used for each.

To keep the engine running at 2,000 Hz (100% speed), a commercial diesel engine governor is used to schedule the fuel to the engine via a fuel torque control motor.

The PLC's analog input card requires signals in the 0-10V range. Appropriate signal conditioning was used to convert engine speed and thermocouple readings into the appropriate voltage ranges. The team initially faced some challenges getting accurate speed readings at all engine speeds (which determines when the PLC actuates accessories) because the signal pulse changed shape and amplitude. This was easily solved with a single resistor.

A view of the control panel with the DL05 PLC, signal conditioning modules, and fuel governor can be seen in *Figure 2*.

Programming flowchart

Using a **C-more** touchscreen, the operator enters a menu screen and then chooses one of the following options:

1) Run the engine
2) Test the outputs – actuate each output independently to verify functionality
3) Administrator screen adjusts fault setting for both start-up and steady-state running

Continued, p. 30>>

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Student Spotlight Cont.

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Continued from, p. 28

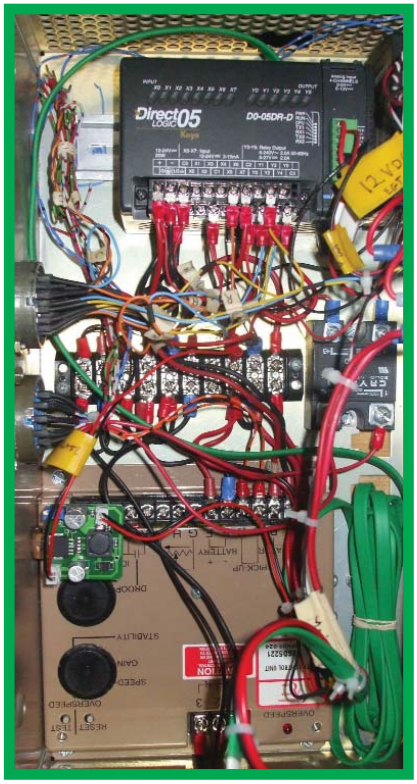

Figure 2: Control Panel

Figure 3: C-more Touch Screen

A view of the engine "start-up" screen showing the temperature, speed, and inputs/outputs from the PLC is shown in *Figure 3*.

Once the engine "start" button is selected, two major states run in parallel in the ladder logic: the starting/running state and the monitoring state, which make sure the parameters of interest are within the appropriate limits. The program switches from starting mode to running mode when the engine reaches 96% speed, at which point the "torch" nozzle is also disengaged. A simplified programming flowchart is shown in *Figure 4*.

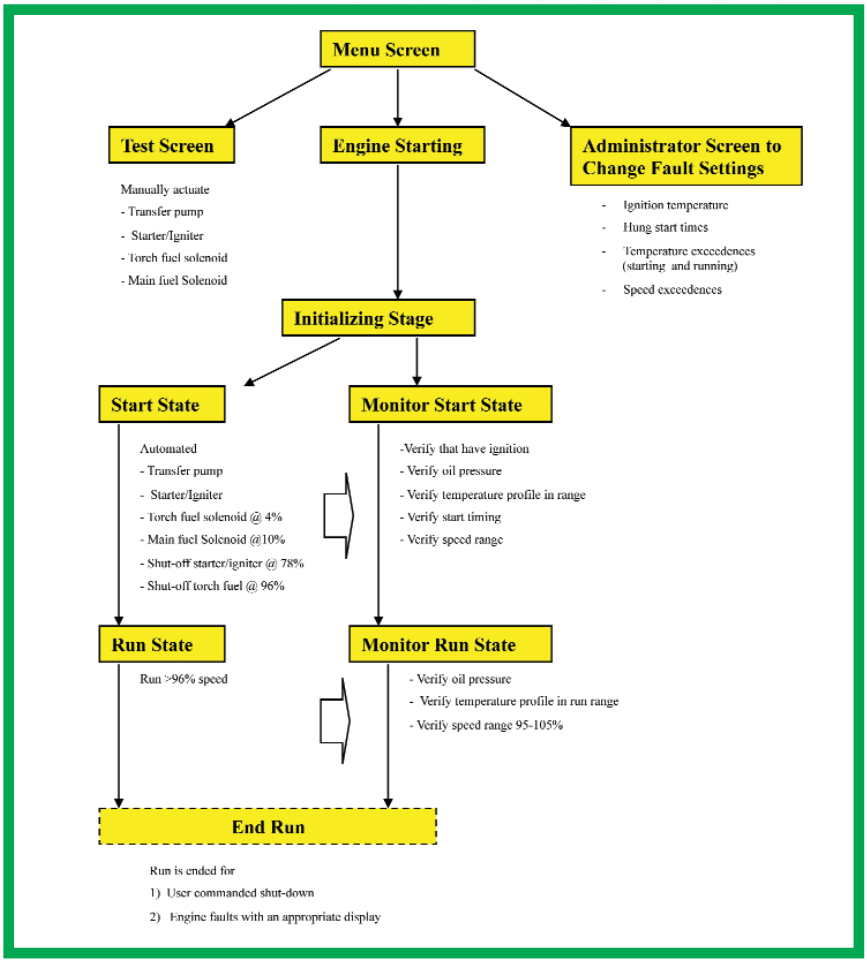

Figure 4: Solar Flowchart

Faults

By automating the engine sequence with the PLC, not only can it be started more smoothly/reliably, but it is also safer and easier to troubleshoot when the engine doe not perform as desired. Some of the faults detected with the program include:

1) **Failure to light** ensures fuel ignition occurs by checking if a set temperature is reached within a prescribed time from the starting.
2) **Temperature limits** The engine has to stay within pre defined temperature ranges for both starting and steady-state running.
3) **Hung start** The engine has to reach 100% (and intermediate speeds) within a desired time and is not allowed to slow down or reverse speed during starting.
4) **Loss of oil pressure** Oil pressure has to be maintained at a given pressure to continue operation.
5) **Speed limits** The engine has to stay within 95-105% while running in steady state.

Application

With the engine fully automated, it can be used in an automotive application, and use the shaft power coming from the planetary gearbox at 6,000 RPM.

The plan is to run the engine at constant speed and use a continuously variable transmission (CVT) to transfer power to the wheels. The CVT primary would be adjusted, possibly hydraulically, by the car foot pedal (throttle) to vary output power.

Continued, p. 33>>

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Student Spotlight Cont.

Jet Engine Club

Continued from, p. 30

Part II: Tiernay TT-10 FADEC Engine

The team is also automating a second gas turbine, a Tiernay TT10. Like the Solar T62T-32A, this turbine was also taken from a military auxiliary power unit (APU).

The engine runs at 50,300 RPM and, through a planetary gearbox, reduces to a 12,000 RPM shaft output speed used to run a DC generator which yields 28V DC (10kW) for starting and running aircraft on the ground.

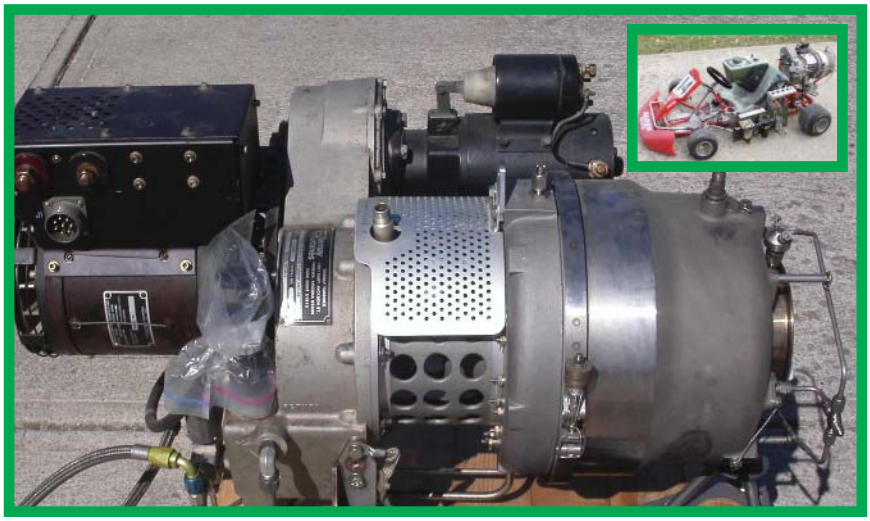


Figure 5: Tiernay TT10

A view of this gas turbine in our intended application (a shifter kart) is shown in ***Figure 5***.

This gas turbine is different from the Solar in that it is run by a Full Authority Digital Electronic Controller (FADEC), which means the engine follows a computer program to run a high-pressure fuel pump to achieve the desired speeds.

The FADEC sends 24V pulses to the pump of varying duration (pulse-width modulation, PWM) to accelerate or decelerate the engine. There are no mechanical inputs to the controller. The only inputs are engine speed (variable), engine temperature (variable), and oil pressure (discrete).

From data logging the engine supplies and from the limited documentation, it was found that the controller would start the engine with a constant output PWM to the fuel pump. Once 50% speed is achieved, the output transitions to a PID loop where PWM output is varied as required.

A screen shot of four of the parameters recorded during data logging is shown in ***Figure 6***.

For this engine, the team chose the ***Direct***LOGIC DL06 (model D0-06DR-D) PLC with the F0-04AD-2 analog input module and the 8-inch ***C-more*** (model EA7-T8C) touchscreen HMI to run the engine at start-up with a pre-defined, fixed output. Once the engine reaches 50% speed, the PLC switches control to a commercial digital engine governor to vary the output to the high-pressure pump and keep it at desired speed.

The PLC actuates all the accessories in sequence, and also switches from the starting PWM circuit to governor control.

In addition, the larger D06 PLC with more relays and card slots was selected to allow for future automation. For example, the intended application requires use of the gas turbine electrical generator to make a turbine-electric go-kart. To vary the throttle electrical output, a control circuit will have to be made that will also be actuated/automated by the PLC.

Status: At press time, the team was in the process of finishing bench tests, finalizing programming of the touch screen in the test stand, and was preparing to start test runs of the gas turbine itself. Once the engine runs reliably, the focus will shift to varying the generator output based on user demand.

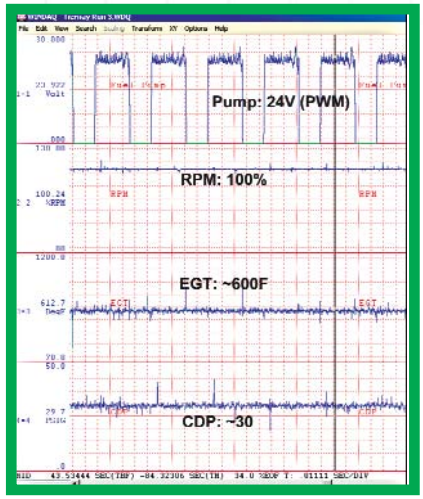


Figure 6: Data Logging parameters recorded

Also, the team now plans to use the Solar T62T-32A gas turbine engine to power a hovercraft, instead of in the original automotive application.

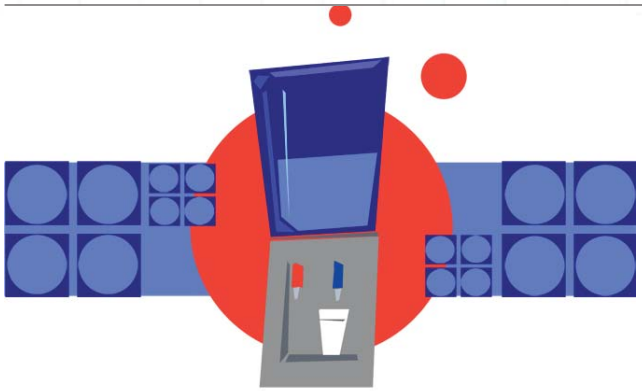
To learn more about the various club projects, feel free to contact William Rossey at: therosseys@cinci.rr.com.

"A good film is when the price of the dinner, the theatre admission and the babysitter were worth it."

– Alfred Hitchcock

The Break Room

Brainteasers & Humor



Punny stuff from the Internet

King Ozymandias of Assyria was running low on cash after years of war with the Hittites. His last great possession was the Star of the Euphrates, the most valuable diamond in the ancient world. Desperate, he went to Croesus, the pawnbroker, to ask for a loan.

Croesus said, "I'll give you 100,000 dinars for it."

"But I paid a million dinars for it," the King protested. "Don't you know who I am? I am the king!"

Croesus replied, "When you wish to pawn a star, makes no difference who you are."

A famous Viking explorer returned home from a voyage and found his name missing from the town register. His wife insisted on complaining to the local civic official, who apologized profusely saying, "I must have taken Leif off my census."

An Indian chief was feeling very sick, so he summoned the medicine man. After a brief examination, the medicine man took out a long, thin strip of elk rawhide and gave it to the chief, telling him to bite off, chew, and swallow one inch of the leather every day. After a month, the medicine man returned to see how the chief was feeling. The chief shrugged and said, "The thong is ended, but the malady lingers on."

Evidence has been found that William Tell and his family were avid bowlers. Unfortunately, all the Swiss League records were destroyed in a fire. ... So we'll never know for whom the Tells bowled.

Brainteasers

1.) Widget Not

The WidgetMaker2000 had only been making widgets for an hour before something in the drive train malfunctioned. The machine had to finish the production run at 3/5ths of its normal speed. This caused a two-hour delay for the completion of the production run. The operator explained that if the machine could have finished just 50 more widgets before experiencing trouble, the delay would have been forty minutes shorter. ***Can you determine how many widgets were produced in this production run?***

2.) Hardheaded Flooring

A hardwood floor manufacturer produces boxes of flooring with exactly 297 linear feet of flooring. They require that each box contain 16 pieces, with each piece being an even number of feet in length. They also promise that eight of those pieces will be of the longest length with the remaining pieces made up of some combination of boards that may be either 1, 2, or 3 feet shorter than the eight longest. ***Can you determine the lengths of the 16 boards?***

3.) Play Floor Square

Two square rooms are to be tiled with 1 foot square tiles. The total square footage of both rooms is 2120 sq ft. One of the rooms is 12 feet larger (on each sidess) than the other. ***Can you determine the dimensions of the two rooms?***

"People everywhere confuse what they read in newspapers with news."

– A. J. Liebling

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5-port managed Ethernet switch with (5) 10/100BaseT RJ45 Ethernet ports	$445.00 SE-SW5M
8-port managed Ethernet switch with (8) Gigabit RJ45 Ethernet ports and (4) combo SFP ports	$1,290.00 SE-SW8MG-4P
16-port managed Ethernet switch with (16) 10/100BaseT RJ45 Ethernet ports	$1,150.00 SE-SW16M

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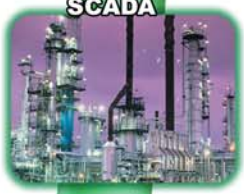

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